OPTO ENGINEERING

INSTRUCTIONS MANUAL

LTIC1CH-A1-4

Analogue lighting controller 1 CH

ACCESSORIES

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INDEX

1. Disclaimer

Always deploy and store Opto Engineering products in the prescribed conditions in order to ensure proper functioning. Failing to comply with the following conditions may shorten the product lifetime and/or result in malfunctioning, performance degradation or failure.

Ensure that incorrect functioning of this equipment cannot cause any dangerous situation or significant financial loss to occur. It is essential that the user ensures that the operation of the controller is suitable for their application. All trademarks mentioned herein belong to their respective owners.

Except as prohibited by law:

- All hardware, software and documentation are provided on an “as is” basis
- Opto Engineering accepts no liability for consequential loss, of any kind

Upon receiving your Opto Engineering product, visually examine the product for any damage during shipping. If the product is damaged upon receipt, please notify Opto Engineering immediately.

2. Safety notes

Please read the following notes before using this controller. Contact your distributor or dealer for any doubts or further advice.

This device must not be used in an application where its failure could cause a hazard to human health or damage to other equipment. Keep in mind that if the device is used in a manner not foreseen by the manufacturer, the protection provided by its circuits and by its enclosure may be impaired.

This is a low voltage device. As such, the potential difference between any combination of applied signals must not exceed, at all times, the supply voltage. Higher voltages may cause a fault and can be dangerous to human health.

This device has limited protection against transients caused by inductive loads. If necessary, use external protection devices like fast diodes or, better, specific transient protectors.

The user must be careful to connect the inputs and outputs correctly and to protect the output wiring and load from unintentional short-circuits. When the device is switched off, there is still energy stored in the internal capacitors for at least five minutes.

When operating the controller at the maximum ratings it can get very hot. The controller should be positioned where personnel cannot accidentally touch it and away from flammable materials. Never exceed the power ratings stated in the manual.

3. Product end-of-life handling

Observe the following guidelines when recycling this equipment or its components.

Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product’s end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

This symbol indicates that this product complies with the applicable European Union requirements according to the **WEEE (Waste Electrical and Electronic Equipment) Directive 2012/19/EU**

4. General description

Any machine vision application employs some kind of light controller. Light controllers are widely used to both optimize illumination intensity and obtain repeatable trigger sequencing between lights and vision cameras.

This controller is a compact unit intended for continuous, low flickering lighting applications in computer vision. It includes power supply conditioning and current intensity control.

Use the 4-way dip switch accessible from the front panel to select the range of the output current according to the light specification. The output current can then be adjusted using either the front panel knob or an external analogue 0-10 V dimming signal. A logic 0-24 V enable input can be used to turn the connected light on and off. A logic 0-24 V fault output is provided to signal overheating or malfunction.

An auxiliary thermal sensor input can be used to sense the light temperature (if a thermal sensor is available in the light). An auxiliary fan output can be used to supply an external cooling fan (if a fan is available in the light).

4.1. Benefits of current control

Most LED manufacturers suggest their products to be driven using a constant current source, not a constant voltage source. This is because, using a constant voltage driving, small variations in temperature or voltage at the LEDs can cause a noticeable change in their brightness.

Brightness control with voltage is also very difficult because of the non-linearity of brightness with voltage. On the contrary, the brightness is approximately linear with current, so by driving the LEDs with a known current, intensity control is linear.

This analogue controller has a single, programmable, current-controlled continuous output with current ranging from zero up to 4 A.

5. Getting started

Carefully read the sections on Safety Notes and Heat Dissipation and check the product fits your needs. Mount the controller using a DIN rail as described in the section on Mechanical fixing.

Connect the controller as in the section on Connections. When the controller powers up it should show the POWER LED lit with a stable green colour.

Read the section on Operation.

6. Mechanical fixing

The controller must be mounted on a DIN rail. Allow free flow of air around the unit. The controller has an IP rating of 20 and should be installed so that moisture and dirt cannot enter it.

An enclosure may also be required for other parts of the system such as power supplies. That enclosure would provide both mechanical and environmental protection in industrial applications.

7. Heat dissipation

The controller integrates several analogue circuits to produce the constant current output. This means that it generates heat which needs to be dissipated. The operating temperature range is 0 °C to 40 °C.

The controller can approximately dissipate an average power of about 10 W.

The maximum permissible controller temperature is 90 °C. If the temperature rises above 90 °C, the controller switches off the light output. The light output is then reactivated once the temperature falls below 70 °C.

There are several ways to reduce the heat generated by the controller. The simplest way would be to turn the light off when not needed. If the light is on only when necessary, the generated heat can be drastically diminished. Another opportunity would be to reduce the output current, if permitted by the application.

The controller must be powered with a fixed supply voltage of either 24 V or 48 V DC. Intermediate voltages are strictly not allowed. As a general guideline, use either 24 V or 48 V if the light power is less than 50 W and use 48 V if the light power is 50 W or more.

8. Connections

See the next sections for information about connections. All connections are made via screw terminals on both the top and bottom panels of the controller (front view). Check all connections carefully before switching on the equipment.

As anticipated, the controller has a single 24 V or 48 V DC power supply. Intermediate voltages are not supported and must be avoided. Use either 24 V or 48 V if the light power is less than 50 W and use 48 V if the light power is 50 W or more.

The controller has an external analogue 0-10 V dimming input that can be used to adjust the value of the output current and consequently the intensity of the light emitted.

The controller has a logic 0-24 V enable input that can be used to switch the light output on and off. The enable input can be used to reduce power dissipation or to protect the end user from photobiological and other hazards that can occur during fault conditions. The enable input is active high.

The controller has a logic fault output, used to signal overheating or malfunction. This output is internally pulled up to the supply voltage (either 24 V or 48 V). The fault output is active low.

An auxiliary thermal sensor input and an auxiliary cooling fan output are also provided as signals on the terminal blocks.

8.1. Layout of connectors

The drawing in *Figure 1: connectors on the controller* depicts all the controller connections, which are easily accessible on both the top and bottom sides of the controller (front view). As indicated in the drawing, connectors are identified by their unique designators (P1 and P2).

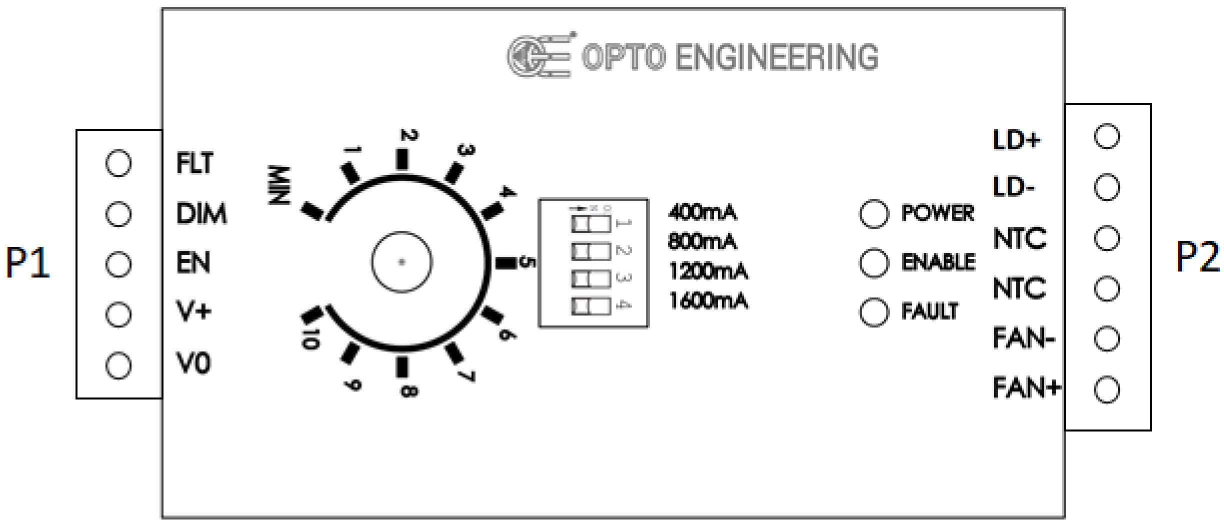


Figure 1: connectors on the controller

The connectors are briefly described below. A detailed description follows in the next sections.

- Connector P1 is used for:
  - The power supply
  - The enable input signal
  - The external dimming input signal
  - The fault output signal
- Connector P2 is used for:
  - The light
  - An auxiliary thermal sensor (generally mounted inside the light)
  - An auxiliary fan for the active cooling of the light

For connectors P1 and P2 a mating plug is provided in the controller package. For convenience the relevant manufacturer part numbers are listed in *Table 1: mating plugs for the controller connectors*. Even if equivalent mating plugs may be available, these are the recommended components.

Connector designator	**Manufacturer**	**Mating plug part number**
P1	Phoenix Contact	1792979
P2	Phoenix Contact	3705390

Table 1: mating plugs for the controller connectors

8.2. Power supply, enable and dimming inputs, fault output

Connector P1 (see *Figure 1: connectors on the controller*) is used for the power supply, the enable input, the dimming input and for the fault output.

Connector pinout, ordered from left to right, is listed in *Table 2: pinout of connector P1*.

Number	**Name**	**Description**	**Note**
1	FLT	Fault output	Internally pulled up to supply voltage (either 24 V or 48 V)
2	DIM	Dimming input	Used to adjust the output current
3	EN	Enable input	Connect to 12 V or greater to turn on the controller output and supply the light
5	V+	Power supply. Positive terminal	
6	V0	Power supply. Negative terminal	

Table 2: pinout of connector P1

See the following section for more information about connector P1.

8.2.1. Power supply

The power supply voltage must be 24 V or 48 V. Intermediate voltages are not allowed and must be avoided. Use either 24 V or 48 V if the light power is less than 50 W and use 48 V if the light power is 50 W or more. A dedicated and well-regulated switching power supply is required. The external power supply must be capable of supplying the current needed for the light at the selected supply voltage.

The controller is not equipped with an internal fuse, so choose a power supply unit that limits its output current by design or use a suitable protecting fuse. The maximum allowed current must be 6 A. The fuse should be appropriately de-rated if mounted in an enclosure, as the inside temperature can be higher than the ambient temperature.

Ensure that the wire gauge used for the power connections is appropriate for the current to be drawn. The power supply low voltage and mains wirings should be separately routed.

Power supply is delivered to the controller using pin 5 (V+) and pin 6 (V0) of the screw terminals of connector P1. Connector pinout, ordered from left to right, is listed in *Table 2: pinout of connector P1*.

Ensure that the polarity of V+ and V0 is correct. When the controller is powered the POWER green LED on the top panel is continuously lit.

8.2.2. Enable input

The controller has an enable input that can be used to turn the light output on and off. To activate the output and switch the light on, connect the enable input to a voltage source of 12 V or greater. The input impedance of this signal is 20 kΩ.

The enable input signal is delivered to the controller using pin 3 (EN) and pin 6 (V0) of the screw terminals of connector P1. Connector pinout, ordered from left to right, is listed in *Table 2: pinout of connector P1*.

When the controller is enabled, the ENABLE yellow LED on the top panel is continuously lit.

8.2.3. Dimming input

The controller has two different ways to adjust the value of the output current and consequently the intensity of the light. The basic way is to use the knob mounted on the controller front panel (see section Operation). The alternative way is to use the external analogue dimming input.

If the external dimming input is used, the output current can be adjusted by applying an analogue signal (from 0 V up to 10 V) between pin 2 (DIM) and pin 6 (V0) of the screw terminals of connector P1. Connector pinout, ordered from left to right, is listed in *Table 2: pinout of connector P1*.

If the dimming signal is driven by the minimum voltage (0 V) the controller will deliver the lowest output current, corresponding to the lowest light intensity.

If the dimming signal is driven by the maximum voltage (10 V) the controller will deliver the highest output current, as selected by 4-way dip switch, corresponding to the highest light intensity.

For the dimming voltages between 0 V and 10 V the controller will deliver an intermediate output current (from the lowest output current up to the maximum current value selected by 4-way dip switch), corresponding to an intermediate light intensity.

The input impedance of this signal is 4.7 kΩ.

8.2.4. Fault output

The controller has a fault output that is used to signal overheating or malfunction. This output is internally pulled up to the supply voltage (either 24 V or 48 V) using a 10 kΩ resistor and is active low. The maximum sink current is 10 mA.

If a fault condition is detected the controller output is turned off, the fault output is driven low and the FAULT red LED on the top panel is continuously lit. The controller will automatically resume regular operation once the fault condition is removed.

The controller fault output signal can be monitored using pin 1 (FLT) and pin 6 (V0) of the screw terminals of connector P1. Connector pinout, ordered from left to right, is listed in *Table 2: pinout of connector P1*.

8.3. Light output, thermal sensor input and fan output

Connector P2 (see *Figure 1: connectors on the controller*) is used for the light output, for an auxiliary external thermal sensor in the light (if available) and to drive an auxiliary cooling fan in the light (if available).

Connector pinout, ordered from left to right, is listed in *Table 3: pinout of connector P2*.

Number	Name	Description	Note
1	LD+	LED anode	
2	LD-	LED cathode	
3	NTC	Thermal sensor	
4	NTC	Thermal sensor	
5	FAN-	Negative terminal for cooling fan	
6	FAN+	Positive terminal for cooling fan	

Table 3: pinout of connector P2

See the following section for more information about connector P2.

8.3.1. Light output

Light output is available on pin 6 (LD+) and pin 5 (LD-) screw terminals of connector P2. Connector pinout, ordered from left to right, is listed in *Table 3: pinout of connector P2*.

Before powering up the controller, ensure that the polarity of LD+ and LD- is correct. Make also sure you set the correct current range for the light (see section Operation). See the light datasheet and manual for the electrical ratings of the light.

8.3.2. Auxiliary thermal sensor input

The controller allows for the connection of an auxiliary external temperature sensor. The intended temperature sensing element is a NTC (Negative Temperature Coefficient) thermistor with coefficients R_{25} = 10 kΩ and $B_{25/85}$ = 3610 K. A suitable component is the Vishay NTCS0603E3103FMT.

The thermistor signals are available on pin 3 (NTC) and pin 4 (NTC) screw terminals of connector P2. Connector pinout, ordered from left to right, is listed in *Table 3: pinout of connector P2*.

The two terminals can be connected freely to the external thermistor, as the component is not polarized.

8.3.3. Auxiliary cooling fan output

The controller allows for the connection of an auxiliary external cooling fan with a nominal voltage of 24 V and a maximum supply current of 1 A. Inside the controller there is a PWM (Pulse-Width Modulation) driver that allows to control the fan speed indirectly by modulating the pulse width of the fan power supply.

The duty cycle of the fan power supply is generally automatically varied by the controller between a minimum value and a maximum value according to the actual temperature of the light, as measured by the auxiliary thermal sensor.

The controller implements a fan control algorithm as follows:

- If the temperature reported by the auxiliary thermal sensor is lower than 70 °C the fan will run at the minimum speed
- If the temperature reported by the auxiliary thermal sensor is higher than 85 °C the fan will run at the maximum speed
- For temperatures between 70 °C and 85 °C the fan will run at an intermediate speed, proportional to the temperature

The fan output signals are available on pin 5 (FAN-) and pin 6 (FAN+) screw terminals of connector P2. Connector pinout, ordered from left to right, is listed in *Table 3: pinout of connector P2*.

8.4. Cable size and length

The actual connecting cables must be chosen on the basis of their load sinking current, the length, the working voltage and the cable materials characteristics. Special ambient conditions may further restrict the choice to a specific kind of cable.

The *Table 4: cable wire size and length* lists the recommended wire sizes and maximum allowed lengths for all the cables coming to and leaving from the controller. American Wire Gauge (AWG) is the wire measurement system used by the United States and Canada, while mm is the metric system of measurement used across Europe and in most of the world.

Port	**Recommended wire size**		**Maximum length [m]**
	mm^2	**AWG**	
Power supply	1.5	15	5
Light output	0.75	18	5
Control and status signals	0.25	24	5
External fan	0.5	20	5
External temperature sensor	0.25	24	5

Table 4: cable wire size and length

9. Visual indicators

There are three LEDs on the top panel of the controller (see *Figure 1: connectors on the controller*).

The exact meaning of each of the LEDs is listed in *Table 5: meaning of the LEDs*. The LEDs of the top panel of the controller are identified by a unique label printed next to them.

Number	**Name**	**Colour**	**Description**
1	POWER	Green	Stable when power supply is present
2	ENABLE	Yellow	Stable when enable signal is high
3	FAULT	Red	Stable when an error condition is detected

Table 5: meaning of the LEDs

10. Wiring diagrams

The following wiring diagrams describe some of the possible configurations for the controller.

10.1. Wiring example #1: basic connection

In the schematic diagram of *Figure 2: example schematic #1* the controller drives a light and a fan (generally mounted in the same light).

As shown, if required for the application, a safety switch may be included in the circuit to disable the controller output in order to protect the end user from photobiological hazard. The same switch can be used to turn the light on and off as needed by the application.

In this example the maximum output current is selected by the 4-way dip switch as 1200 mA. It can then be adjusted from zero to the maximum value using the knob on the front panel.

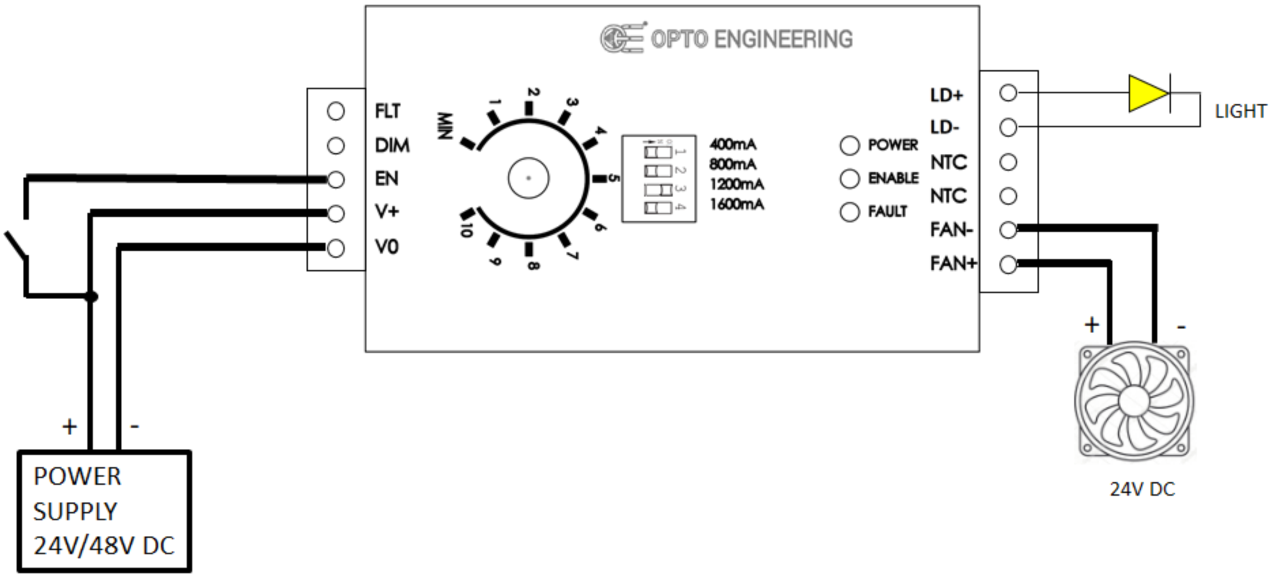


Figure 2: example schematic #1

10.2. Wiring example #2: advanced connection

In the schematic diagram of *Figure 3: example schematic #2* the controller drives a light and a fan while monitoring the light temperature using a thermal sensor. Generally, the thermal sensor is mounted in the light.

As shown, in this case the controller is always enabled (will be automatically disabled only during fault conditions).

In this example the maximum output current selected by the 4-way dip switch is 2800 mA (= 1200 mA + 1600 mA). The intensity of the light can then be adjusted using the depicted external voltage source (possibly variable between 0 V and 10 V) connected to the external dimming input.

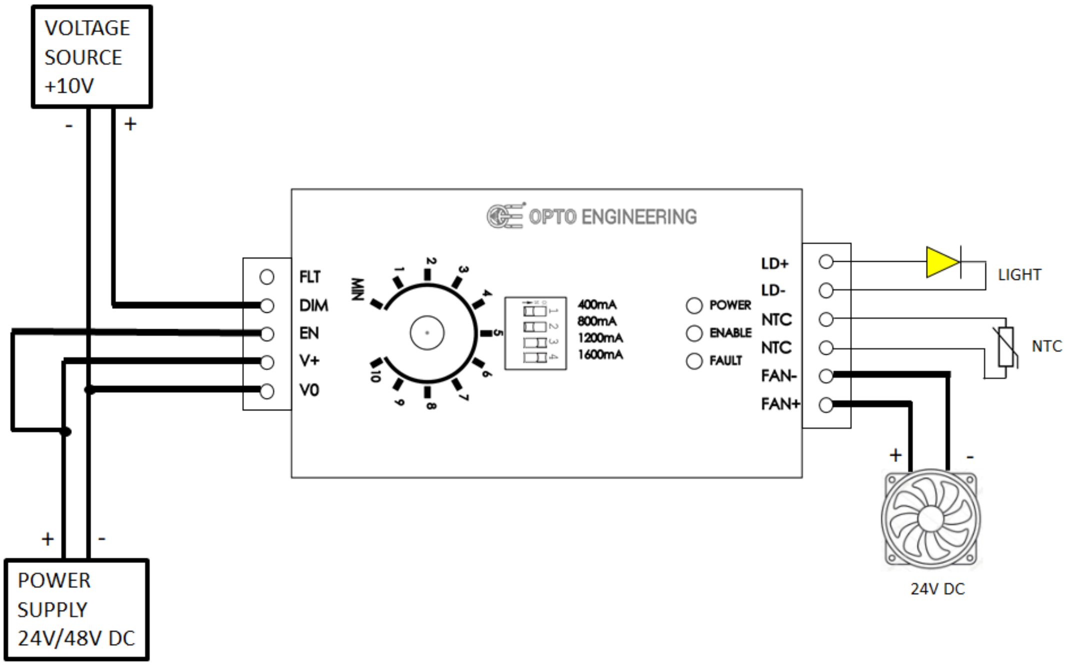


Figure 3: example schematic #2

11. Operation

The controller can be powered with a supply voltage of either 24 V or 48 V. As stated before, intermediate voltages are not allowed and must be avoided. As a general indication, use either 24 V or 48 V if the light power is less than 50 W and use 48 V if the light power is 50 W or more. Use of a 24 V supply with a light power of 50 W or more is highly discouraged and can result in the controller overheating and malfunctioning.

Before powering the controller ensure that all the connections are correct and the current range is adequate for the light (see the light datasheet and manual for details on this topic).

For better results be careful that the selected current range is the lowest range capable of delivering the required output current. Such a selection reduces noise in the electronics and thus flickering in the light is minimized.

There are several ways to configure and use the controller. Some examples follow:

- Locally, by using the 4-way dip switch and the knob on the top panel with the digital enable input tied directly to the supply voltage
- Remotely, by using the 4-way dip switch, the external analogue dimming input and the digital enable input

11.1. Operation in continuous mode

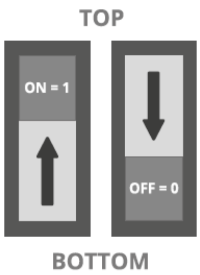
This controller normally operates in continuous mode.

There are four basic output current ranges which can be selected using the 4-way dip switch. These are:

- 0 – 400 mA
- 0 – 800 mA
- 0 – 1200 mA
- 0 – 1600 mA

These four ranges can be combined together to obtain ten different output current ranges, nominally from zero up to 4 A. All the sixteen possible combination of the 4-way dip switch are listed in *Table 6: dip switch combination and output current ranges.* Note combination “0000” is not allowed and must not be used at any time.

Each of these dip switches is enabled (1 state) when its corresponding mechanical lever is in the ON position (i.e. moved toward the top of the controller), while it is disabled (0 state) when its corresponding mechanical lever is in the OFF position (i.e. moved toward the bottom of the controller).



Dip switch states:
ON position (1 state): lever moved towards the top
OFF position (0 state): lever moved towards the bottom

Dip switch				**Max output current (mA)**
1 (400 mA)	2 (800 mA)	3 (1200 mA)	4 (1600 mA)	
0	0	0	0	Not allowed
1	0	0	0	400
0	1	0	0	800
1	1	0	0	1200
0	0	1	0	
1	0	1	0	1600
0	0	0	1	
1	0	0	1	2000
0	1	1	0	
1	1	1	0	2400
0	1	0	1	
1	1	0	1	2800
0	0	1	1	
1	0	1	1	3200
0	1	1	1	3600
1	1	1	1	4000

Table 6: dip switch combination and output current ranges

For each selected range the current can be linearly adjusted in two different ways. The basic way is to use the knob mounted on the controller front panel. The alternative way is to use the external analogue dimming input (see section Dimming input).

Both the knob and the external analogue dimming input allow to adjust the output current from zero up to the maximum current value selected by the 4-way dip switch. To be able to adjust the output current via the knob, the external analogue dimming input signal must be left floating.

If an external dimming signal is used, the output current can be adjusted by applying an analogue signal (from 0 V up to 10 V) at the dimming input (see section Dimming input). In this case, it is important that the external driving source has an output resistance lower than 470 Ω in order to override the contribution of the knob.

11.2. Operation in pulsed mode

Although primarily intended for continuous mode operation, this controller also allows slow speed operation in pulsed mode by sequentially turning the enable input signal on and off.

In case of operation in pulsed mode, it is important to note that the controller is not exactly performing such as a strobe controller. In fact, the response time after a change on the enable input signal is approximately 560 µs for light activation and 15 µs for light deactivation, while the output current rising edge takes approximately 140 µs and the falling edge takes approximately 85 µs. This information is collected in the time diagram of *Figure 4: time diagram of the controller output after a change on the enable input*.

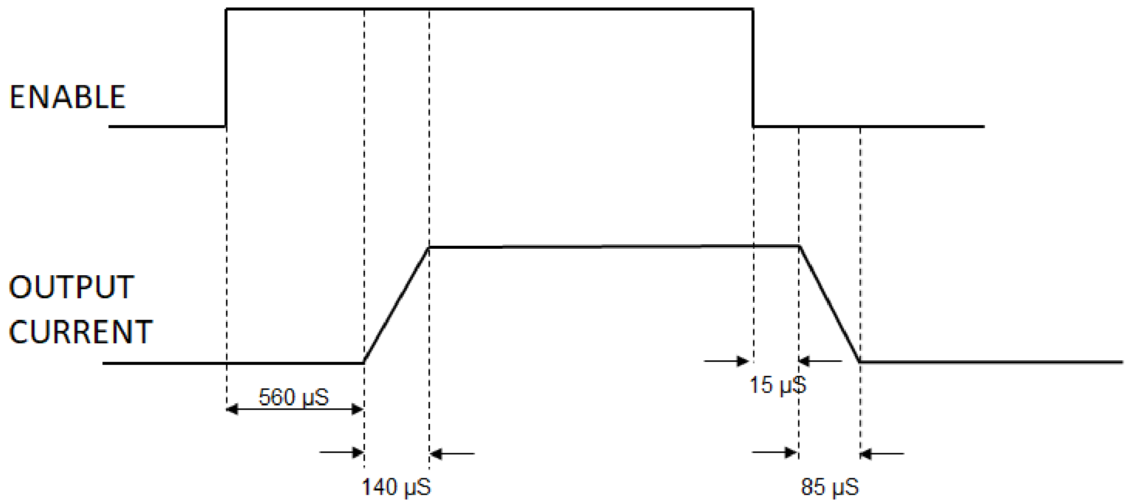


Figure 4: time diagram of the controller output after a change on the enable input

As for the continuous mode, the peak value of the output current pulse can be programmed by using the 4-way dip switch (in order to select the output current range) and the knob, or by using the 4-way dip switch and the external analogue dimming input signal.

The maximum working frequency for pulse operation must be limited to 15 Hz. Higher working frequencies may cause damage or malfunction of the controller.

11.3. Flickering optimization

The power stage is implemented using a switching converter and the output current has a small degree of superimposed switching noise that may result in the flickering of the light at extremely low exposure times.

- In order to minimize this superimposed switching noise, take care to select the lowest current range capable of delivering the output current required by the application
- The switching noise generally decreases as the output voltage increases. To minimize the switching noise for light voltages around 2 V or less it is advisable to artificially increase the controller output voltage by inserting an extra resistor in series with the output. The required resistance may be easily calculated using the Ohm's law

12. Electromagnetic compatibility

This product conforms to CENELEC EN 61326-1:2013 class A requirements for electromagnetic interference (EMI) suppression. EN 61326-1:2013 is equivalent to international standard IEC 61326-1, Ed. 2.0 (2012-07).

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